

Solution for system of n nonlinear functions: Lorenz system Problem

Reference:

Problem taken from Wikipedia

Problem:

The model is a system of three ordinary differential equations now known as the Lorenz equations:

$$dx/dt = \sigma(y - x),$$

$$dy/dt = x(\rho - z) - y,$$

$$dz/dt = xy - \beta z$$

The equations relate the properties of a two-dimensional fluid layer uniformly warmed from below and cooled from above. In particular, the equations describe the rate of change of three quantities with respect to time: x is proportional to the rate of convection.

One normally assumes that the parameters σ , ρ , and β are positive. Lorenz used the values $\sigma = 10$, $\beta = 8/3$ and $\rho = 28$. The system exhibits chaotic behavior for these (and nearby) values.

Mathematical Formulation:

Let x_1 , x_2 , and x_3 represent the parameters for Lorenz System, so the nonlinear equations are:

- $x_1 - x_2 = 0$
- $2x_1 - x_1x_3 - x_2 = 0$
- $x_1x_2 - 3x_3 = 0$

How to use the code:

As the user clicks on the execute button, the console gets displayed.

The user is asked to take the following steps:

- The user is asked for the no. of variable in the equations. In this example it is: **3**.
- Now, User need to enter the initial values of all the variables simultaneously. Here in this case it is: **100(enter) 100(enter) 100**.

After that it will show the zeros of the non-linear multivariables equations.

About the function:

$$[x, v, \text{info}] = \text{fsolve}(x_0, \text{fct}, [\text{fjac}], \text{tol})$$

x_0 : real vector (initial value of function argument).

fct : external (i.e function or list or string).

fjac :external (i.e function or list or string).

tol :real scalar. precision tolerance: termination occurs when the algorithm estimates that the relative error between x and the solution is at most tol. (tol= $1.d-10$ is the default value).

x : real vector (final value of function argument, estimated zero).

v : real vector (value of function at x).

info:termination indicator